

- 1 1. A method for making or monitoring an electronic device, comprising the steps of:
2 measuring an analyte selected from the group consisting of a material in the
3 electronic device, a constituent of the material, a byproduct of the material, a
4 reaction product of a constituent of the material, a contaminant, and a tag;
5 detecting more than one physical, chemical, or physico-chemical property of the
6 analyte;
7 combining the detected properties to produce a signal output;
8 processing the signal output with multivariate analysis to convert the signal
9 output into information representative of a quality of the material, a constituent of
10 the material, or a variable in processing the material.
- 11 2. A method according to claim 1, wherein the multivariate analysis comprises
12 processing the signal output with a pattern recognition algorithm sufficient to
13 classify, compare, or discriminate the material based on at least one member
14 selected from the group consisting of quantity, quality, performance, physical,
15 chemical, physico-chemical properties, environmental effects, or timing effects.
- 16 3. A method according to claim 2, wherein the multivariate analysis uses
17 unsupervised statistical pattern recognition.
- 18 4. A method according to claim 2, wherein the multivariate analysis uses supervised
19 statistical pattern recognition.
- 20 5. A method according to claim 1, wherein the analysis is at least one member
21 selected from the group consisting of classical least squares (CLS), inverse least
22 squares (ILS), partial least squares (PLS), principal components analysis (PCA),
23 principle components regression (PCR), nonlinear principle components
24 regression (NLPCR), nonlinear partial least squares (NLPLS), deterministic finite-
25 state automata (DFA), Fast Look-up Algorithm for String Homology (FLASH),
26 pattern recognition, and neural networks.
- 27

- Sub A2
6. A method according to claim 1 wherein the quality analysis comprises sensory evaluation of the sample materials by human paneling.
7. A method according to claim 1 wherein a near-field probe comprises a coated optical fiber is used in measuring the analyte.
8. A method according to claim 1, wherein the analyte is a gas, a vapor, or suspended in a gas.
9. ~~A method according to claim 1, wherein a mixture of analytes is screened, and the signal output represents the overall properties of the mixture.~~
- Sub A3
10. A method according to claim 8 comprising collecting gases by a static or dynamic headspace technique.
11. A method according to claim 10, wherein at least one member of the group consisting of heat, electromagnetic radiation, electricity, magnetism, and mechanical vibration at least assists in transferring the analyte from the material to a gaseous or vaporized form.
12. A method according to claim 8 wherein the gas sensing means comprises at least one member of the group consisting of a semiconductor gas sensing device, a conductive polymer gas sensing device, a surface acoustic wave gas sensing device, a microbar sensing device, a micromechanical probe, a quartz crystal microbalance, and an optical sensor.
13. A method according to claim 8 wherein the gas sensing means comprises at least a metal oxide semiconductor gas sensing device.
14. A method for monitoring a process of preparing or assembling parts into an electronic assembly, comprising the steps of:
collecting a gaseous or vaporized species from at least one member selected from the group consisting of a circuit board, a solder paste, a solder, a solder flux, an epoxy, a conductive epoxy, a resin, an electronic component, a discrete component, a thermally conductive paste, an adsorbent, an encapsulant, a coating, a filler, a lubricant, a reactant, a byproduct, a contaminant, and a tag;

1 screening at least one of the gaseous or vaporized species with a screening
2 means comprising a n number of sensing probes, where n is an integer of at
3 least one so that more than one physical, chemical, or physico-chemical change
4 which defines the information is detected by the probe to produce at least one
5 signal output; and
6 analyzing the signal output with multivariate analysis to convert the signal output
7 into information representative of the process and or its components.

8 ~~15. A method according to claim 13, wherein a part is a circuit board or a multichip~~
9 ~~module.~~

10 ~~16. A method according to claim 13, wherein the contaminant is at least one member~~
11 ~~of the group consisting of anions, organic acids, organics, and particulates.~~

12 ~~17. A method according to claim 13, further comprising the step of using the~~
13 ~~information in a feedback loop to control the process.~~

14 18. A method according to claim 15, wherein the circuit board is in a soldering
15 operation.

16 19. A method according to claim 15, wherein the circuit board uses surface mount
17 technology.

18 ~~20. A method for monitoring a process of packaging or encapsulating a material used~~
19 ~~in electronics or optics with a package or encapsulant, comprising the steps of:~~
20 ~~collecting a gaseous or vaporized species from at least one member selected~~
21 ~~from the group consisting of the material, the package, and the encapsulant;~~
22 ~~screening at least one of the gaseous or vaporized species with a screening~~
23 ~~means comprising a n number of sensing probes, where n is an integer of at~~
24 ~~least one so that more than one physical, chemical, or physico-chemical change~~
25 ~~which defines the information is detected by the probe to produce at least one~~
26 ~~signal output; and~~
27 ~~analyzing the signal output with multivariate analysis to convert the signal output~~
28 ~~into information representative of at least one member selected from the group~~
29 ~~consisting of the process, the material, the package, and the encapsulant.~~

- 1 21. A method according to claim 20, wherein the material and the package are part
2 of at least one member selected from the group consisting of an integrated
3 circuit, a multichip module, an optoelectronic device, an integrated circuit board,
4 a memory module, and an electronic device.
- 5 22. A method according to claim 20, wherein at least one analyte is water or residual
6 solvent and the information represents the degree of popcorning.
- 7 23. A method according to claim 20, wherein the encapsulant is a water barrier or a
8 moisture barrier.
- 9 24. A method for probing at least the quality of a material used in electronics or
10 optics, the method comprising the steps of:
11 selecting a sample of the materials from a storage environment or a
12 manufacturing process;
13 collecting a gas from the sample;
14 analyzing the gas with n number of sensing probes, where n is an integer of at
15 least one so that more than one physical, chemical, or physico-chemical property
16 detected by the probe and combined to produce a signal output;
17 performing a multivariate analysis on the signal output to characterize the
18 material, the storage environment, or the manufacturing process.
- 19 25. A method according to claim 24, comprising a step of selecting a component or
20 processing aid used in plastic molding compounds.
- 21 26. A method according to claim 24, wherein the plastic molding consist of about
22 45% to about 95% inorganic filler and about 5% to about 55% organic materials.
- 23 27. A method according to claim 24; wherein the inorganic filler consists of silica.
- 24 28. A method according to claim 24, wherein the organic materials comprises some
25 resin compounds.
- 26 29. A method according to claim 24, wherein the organic materials comprises some
27 hardener or catalyst compounds.

- 1 30. A method according to claim 24, wherein the material comprises a
2 semiconductor.
- 3 31. A method according to claim 30, comprising a step of selecting a semiconductor
4 materials comprising insulating dielectric materials.
- 5 32. A method according to claim 30, comprising a step of selecting a semiconductor
6 materials comprising a modified silicon wafer.
- 7 33. A method according to claim 24, wherein the materials comprises oxides.
- 8 34. A method according to claim 24, wherein the material comprises a
9 superconductor.
- 10 35. A method according to claim 24, wherein the material comprises a plastic.
- 11 36. A method according to claim 24, wherein the material comprises a composite.
- 12 37. A method for characterizing an electronic device, the method comprising the
13 steps of:
14 screening the electronic device with n number of sensing probes, where n is an
15 integer of at least one so that more than one physical, chemical, or physico-
16 chemical property detected by the probe and combined to produce a signal
17 output;
18 processing the signal output with multivariate analysis to convert the signal
19 output into information representative of the device, an operating characteristic of
20 the device, or a property of the device.
- 21 38. A method according to claim 37, further comprising analysis of electronic signals
22 in the device and n is an integer greater than one.
- 23 39. A method according to claim 37, further comprising using the information to
24 control the device.
- 25 40. A method according to claim 37, wherein the screening is of a gas or a vapor
26 within the electronic device.

1 41. A method according to claim 37, wherein the operating characteristic is device
2 performance, optimization, analysis, or failure prediction according to device
3 specification.

4 42. A method according to claim 37, wherein the device is a data storage disk drive
5 ~~or a component within the data storage disk drive~~

6 ~~43. An apparatus for probing at least the quality of a material used in electronics or~~
7 optics, comprising:

8 a multivariate detector having at least one of a sensing probe, sensing
9 location, or physicochemical property,

10 the multivariate detector capable of detecting an analytes that is at least one
11 member selected from the group consisting of the material, a constituent of the
12 material, a byproduct of the material, and a reaction product of a constituent of
13 the material, and a tag;

14 transmission means, capable of transmitting a signal between the multivariate
15 detector and a data acquisition system, capable of converting the signal
16 into raw data;

17 a computational device capable of processing at least part of the raw data using
18 multivariate analysis to create a data set; and

19 an output device capable of displaying, storing, or using the data set.